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CENTRAL FAX CENTER
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FIELD OF THE INVENTION

The present invention relates to vehicle occupant seat detection device and weight responsive classification system. "This is taken from line18-27 of the specification."

BACKGROUND OF THE INVENTION

Weight sensing systems for use with supplemental restraint devices are well known in the art. One such weight sensing system includes sensors positioned in the sitting surface of a seat. These sensors are engaged only when the seat cushion is deflected.

Disclosed embodiments comprise weight sensing unit disposed beneath the vehicle occupant seat detection and weight responsive classification system. " This is taken from line 11-16 of the specification."

SUMMARY OF THE INVENTION

Disclosed embodiments comprise a supplemental restraint system comprising of one or more weight sensing units which are being operatively secured beneath one or more seats in a vehicle, the units being communicatively connected to the vehicle's supplemental restraint system via a computerized system being configured for controlling the deployment force and acceleration used to inflate airbags corresponding to each seat occupied by an occupant. The deployment force for each airbag is determined proportionately based on the weight of the occupant occupying the corresponding seat. "This is taken from line 1-16 of the specification"

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a diagrammatic view of an occupant in a seat in a vehicle employing an embodiment of the present invention.

Figure 2 shows a cross-sectional side view of one embodiment of a load cell as a weight sensing unit according to the present invention.

Figure 3 shows a diagrammatic view of an embodiment of a computerized system according to the present invention.

Figure 4 shows a diagrammatic side cut-away view of an embodiment of an airbag system according to the present invention.

Figure 5 shows another embodiment of the present invention further comprising a smart seat belt system.

Figure 6 shows another embodiment of a weight sensing unit comprising an inflatable or deflatable bag and a device for recording and transmitting values for inflation or deflation of the bag.

Figure 7 shows a diagrammatic view of the present invention comprising seat belt sensors and airbag sensors for controlling the direction of airbag deployment away from occupant's head; and

Figure 8 shows a cross sectional view of one version of an airbag used with the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

The supplemental restraint system **10**, according to the present invention comprises one or more weight-sensing units **12** operatively secured beneath one or more seats **14** in a vehicle (not shown), the units being communicatively connected to the vehicle's supplemental restraint system via a computerized system **16** that intelligently controls the deployment force and acceleration used to inflate airbags **18** corresponding to each seat occupied by an occupant **20**. The deployment force for each airbag **18** is determined proportionately based on the weight of the occupant **20** occupying the corresponding seat. Other features of the present invention may include the storage and use of other information regarding occupants in the vehicle, such as whether seatbelts **22** are buckled and whether arms and legs are in proper safety enhancing positions.

Figure **1** shows an occupant **20** sitting in a seat **14**. In one embodiment, the weight-sensing unit **12** comprises a load cell **24** secured beneath the seat **14**. In other embodiments, more than one load cell **24** is secured beneath the seat **14**. Each load cell **24** comprises one or more strain gauges **26** that are configured to sense a force applied to them when an occupant **20** sits on the seat **14**. The strain caused by the force of the occupant **20** on the seat is measured by the gauge **26** which delivers an electric line signal to the computerized system **16** for processing in accordance with the present invention.

In one embodiment, the computerized system **16** comprises a control module **28** electronically connected to a central processing unit (CPU) **30**. A control module **28** receives the electric line signals from each load cell **24** and identifies particular seats **14** in the vehicle from which signals are received. As a result, in one embodiment, the control module **28** categorizes data received as pertaining to functionality of one or a set of airbags **18** corresponding to a particular seat **14** in the vehicle. Similarly, in other embodiments, the control module **28** categorizes data as being insufficient for activating one or a set of airbags **18** corresponding to a seat **14** because there is no occupant **20** for that seat or because a small child is the occupant. In yet other embodiments, the control module **28** will only activate airbags **18** for a seat **14** in which the load cells **24** detect an occupant **20** over about 20 lbs.

In one embodiment, the control module **28** receives electric line signals from load cells **24** as analog signals. In other embodiments, the control module converts analog signals it receives into digital signals. In yet other embodiments, the digital signals are converted into binary signals for using a plurality of transistorized switches (not shown) for processing weight value data and communicating such data to the various electronic and computer components in the system **10**.

The control module **28** delivers data from load cells **24** to the CPU **30** comprising read only memory (ROM) **32** that has a basic input output system (BIOS) **34**. The CPU **30** also comprises random access memory (RAM) **36** used by at least one software program **38** in the CPU **30** configured for calculating occupant weight values. The BIOS **34** stores the load cell data as a weight measurement in an address line **40** in the BIOS. The RAM **36** runs the software program **38** to access the address line **40** to obtain the weight measurement and communicates it to the software program **38** in the CPU **30** that calculates and confirms the weight measurement, and determines the operating weight value for the occupant **20** in each seat **14**.

The operating weight value is then communicated to the airbag system **42** corresponding to the seat **14**. In one embodiment, the airbag system **42** comprises one or more airbags **18** operatively connected to a deployment unit **44**. In other embodiments, the deployment unit **44** comprises a combustion chamber **46** that is operatively connected to a canister **48** of igniting gas. In the present invention, the airbag system **42** further comprises a microprocessor **50** electronically connected to an accelerometer **52** that is electrically connected to a canister microprocessor **54** and operatively connected to a sliding pot **56**. The canister microprocessor **54** is electrically connected to a gas release valve relay **58** and an igniter **60**. The sliding pot **56** is operatively connected to the combustion chamber **46**. The release valve relay **58** is operatively connected to a release valve **62** between the gas canister **48** and the combustion chamber **46**.

The operating weight value is received within the airbag system **42** by the microprocessor **50**. The microprocessor **50** delivers a signal corresponding to the operating weight value to the accelerometer **52**, which translates that signal to a corresponding proportionate electric current that energizes the piezoelectric crystals **64** in the accelerometer **52**. The accelerometer comprises at least a coil being electronically configured for receiving the operating weight value for the seat and for adjusting the deployment unit within the airbag system to deploy at least one airbag with a deployment force and acceleration for airbag inflation that are proportionate to the weight measurements. The piezoelectric further comprises energy harvesting methods of converting other forms of energy to electrical energy. In this way, the accelerometer is used in reverse to its normal function. The energy from the crystals **64** is thus also proportionate to the operating weight value, which represents the weight of the occupant **20** in the seat **14**. The electrical energy from the crystals **64** is converted to mechanical energy and employed to displace the mass **66** in the accelerometer **52** the distance D directly related to the crystal energy. The mass **66** abuts a spring **68** which is correspondingly compressed by the displacement of the mass an amount directly related to the distance D. The spring compression is thus directly related to the crystal energy which is directly related to the operating weight value which is based on the weight of the occupant **20** in the seat **14**.

The compression of the spring **68** is the culmination of translating the electrical energy of the current applied to the crystals **64** into the mechanical energy applied to the sliding pot **56** to adjust the opening in the combustion chamber **46** for the gas to expand into the airbag **18** when ignited. In conjunction with this adjustment, the canister microprocessor **54** receives the same signal from the microprocessor **50** that is delivered to the accelerometer **52** that corresponds to the operating weight value. The canister microprocessor **54** utilizes this signal to communicate to the gas release valve relay **58** a specific volume of the gas (not shown) to be released through the release valve **62** into the combustion chamber **46**.

The sliding pot **56** position and the volume of the gas released are calibrated together such that the particular position and the particular volume released generate a specific deployment force and acceleration when the gas is ignited by the igniter **60** when the igniter receives a signal from a collision sensor **70** that a collision has occurred that requires airbag deployment. Because each of the gas release valve relay **58** and the accelerometer **52** (which operatively adjusts the position of the sliding pot **56**) are operated according to signals corresponding to the operating weight value that is based on the weight of the occupant **20** in the seat **14**, the deployment force then corresponds directly to the weight of the occupant in the seat as well in order to optimize the safety of airbag deployment and reduce injuries to occupants as a result.

In one embodiment, a collision sensor **70** signals the control module **28** when a minimum threshold collision severity has occurred in order to start the supplemental restraint system process according to the present invention. In other embodiments, the minimum threshold collision severity comprise a collision substantially equivalent to a vehicle traveling between about 10 m.p.h. and about 15 m.p.h. and hitting a substantially rigid wall (not shown). In yet other embodiments, the collision sensor **70** signals the canister microprocessor **54** directly or the igniter **60** directly to initiate the ignition of the proportionate volume of gas released into the combustion chamber **46**. In the latter case, the system **10** of the present invention prepares the sliding pot **56** position and volume of igniting gas in advance when the operating weight value is determined from the weight of the occupant **20** on the seat **14**. In yet other embodiments, the collision sensor **70** only signals a collision event has occurred when the collision exceeds predetermined speed and collision force thresholds for deployment of the airbags **18**, so that deployment depends on collision severity.

In one embodiment, the ROM **32** comprises a portion that is erasable and programmable (EPROM). The EPROM erases the data in the address line **40** in the BIOS **34** for a particular seat **14** every time an occupant **20** leaves a seat. The EPROM then replaces the data with new data when the occupant or a new occupant takes the seat. The EPROM includes an emulator comprising a housing operatively connected to the EPROM header. The EPROM header is communicatively connected to a circuit board in conjunction with a microprocessor emulator. The housing further comprise data select circuits configured to hold the occupants weight data. A switch on the housing is configured to be turned to place the device in programming mode. The emulator is being programmed for sending data through the EPROM socket on the circuit board via the microprocessor emulator. A switch on the housing is turned to place the device in read-only mode to simulate the EPROM.

In one embodiment, the system **10** of the present invention is used in conjunction with a smart seatbelt system **72**. In other embodiments, the smart seatbelt system **72** will prevent the vehicle from starting unless one or all occupants **20** are wearing their seatbelts **74**. If the occupants **20** decide to put on the seatbelts **74** simply to start the vehicle, as soon as the seatbelts are disconnected, the engine (not shown) will shut off. As a result, the engine will stay running only when all of the seatbelts **74** are worn in all of the occupied seats **14**. In another embodiment, the smart seatbelt system **72** will not allow disconnection of the seatbelt **74** in any way or form unless the engine is first turned off. In this way, a seatbelt processor **76** in the CPU **30** will monitor seatbelt disconnection processes and disable the vehicle's starting means **78** when an occupant **20** is not belted. In yet other embodiments, if a driver decides to stop and pick up another occupant with the engine running, or if the occupant enters the car and fails to put on the seatbelt, the seatbelt processor **76** will deliver a signal to the vehicle starting means **78** to shut the vehicle engine off. The vehicle will only be able to restart when the occupants buckle their seatbelts.

The load cells **24** or other sensors (not shown) in the vehicle can measure additional data relevant to occupants **20** in a vehicle. For example, in one embodiment, sensors are installed inside the vehicle in various locations to sense the position of the occupants **20** within their respective seats **14** or the positions of the respective occupant's arms and legs, such as propped up on the dashboard (not shown). This data may be processed and stored in the CPU **30**. In other embodiments, the CPU **30** may signal a driver of the vehicle regarding unsafe conditions or behavior resulting from different occupant's unsafe body positions. In yet other embodiments, such signals comprise a verbal report. In yet other embodiments, the vehicle is disabled after a preset time until such unsafe behavior or positioning is corrected.

In one embodiment, a weight sensing unit **12** alternative configuration comprises a pressurized, inflatable or inflated bag **80** mounted in the cushion **82** of the seat **14** or beneath the seat. When an occupant **20** occupies a seat **14**, the weight of the occupant will either displace a certain amount of the stored pressure in such bag **80** to a relay valve **84** or initiate the inflatable bag **80** to inflate that specific amount of air to the relay valve **84** that will record the displacement or inflation, as the case may be, as the occupant's weight value. The displaced pressure or the inflated air pressure is the maximum pressure that, when the collision sensor **70** senses a collision, it will signal the accelerometer **52** which then initiates the deployment speed and force of the airbags **18** to correspond to the displaced pressure or the inflation pressure from the bag **80**. The displaced or inflation pressure is the maximum pressure for the maximum acceleration in deployment force of the airbags **18** that may be deployed when the collision sensor **70** senses a sufficient collision force. When the occupant **20** leaves the seat, the weight removed will displace stored pressure or allow reinflation of a deflated bag **80** that is equal to the weight value of the occupant **20**. If the weight value matches or exceeds the stored pressure, then the acceleration and deployment force will have a constant value when a collision is sensed. The displacement or inflation recorded by the relay valve **84** will be transformed into a weight unit for the CPU **30** to recognize. The CPU **30** will then carry on the calculations and computations according to the present invention the same way as for the conventional load cell **24** configuration. In light of the foregoing, alternative means for measuring weight values and communicating them to the CPU **30** are also within the scope of the present invention, which is not intended to be limited by the specific description of a load cell **24** or the above alternative inflatable bag **80** configuration therefor.

In operation, when the ignition switch (not shown) for the vehicle is turned on, an electrical current of 5 milivolts will power the load cell **24** prior to the CPU **30**. When an occupant **20** occupies any of the seats **14** in the vehicle, the load cell **24** or cells for each seat **14** will read the energy from the weight input from the occupant **20** in the seat **14** to communicate with the CPU **30** to enable data processing and computation. The CPU **30**, once powered, runs functions that check all of the hardware components functionality to ensure that they are functioning properly. The CPU **30** comprises a computer chip motherboard (not shown) that contains the CPU operating components **32**, **34**, **36**, **76**, etc. Once the CPU **30** conducts its system functionality check, a boot program (not shown) then checks to see if any occupants **20** have occupied any of the seats **14**. The boot program does this by searching for signals output from the load cell **24**. The boot program then sends the information from the load cells **24** to the address line **40** in the BIOS **34**. The 5 milivolt current from the power source (not shown) of the vehicle is used to generate the electric line signals that are communicated back and forth between the components of the present invention. Components such as the strain gauges **26** and the accelerometer crystals **64** being electrical resistance elements, the current used to convey the electric line signals is thus manipulated as a result of the increase or decrease in the resistance of these elements when current or strain is applied.

In one embodiment, a load cell **24** comprises a corrosion resistant, high alloy steel construction. In yet other embodiments, a load cell **24** comprises a weight measuring capacity of up to about 1,000 lbs. In yet other embodiments, a load cell **24** comprises machined, high steel beams **86** having strain gauges **26** secured thereto. In yet other embodiments, the strain gauges **26** comprise electrical resistance elements sealed with a sealant (not shown) to prevent moisture or contaminants from disrupting strain measuring functions.

In one embodiment, a control module **28** comprises a silicon control rectifier that manages flow of data to the ROM **32** in the CPU **30**. In other embodiments, the data comprises occupant weight information and other in-vehicle information regarding the occupant **20**. The CPU **30** comprises a ROM **32** having EPROM capabilities as well as a BIOS **34**, and the CPU **30** further comprises RAM **36** and a software program **38** running within the RAM. The CPU **30** records information regarding the occupant **20**, including how the occupant changes positions or shifts weight in the seat **14**. The BIOS **34** comprises the basic control over the load cell **24** data stored in the ROM **32**. The ROM contains a special chip (not shown) for the CPU **30** that contains instructions and other information that is not erasable or reprogrammable during the life of the CPU. The RAM **36** comprises the primary memory storage for running the software program **38** that accesses the occupant's information and allows the CPU **30** to calculate the operating weight value, among other data for use in accordance with the present invention.

In one embodiment, a signal amplifier **88** is employed for amplifying the electronic signals delivered from one component of the system **10** to the others.

Although the present invention is designed for use with a supplemental restraint system that utilizes a combustible gas for generating the force and volume for inflating an airbag, it is within the scope of a person or ordinary skill in the art to modify the present invention for use with a standard supplemental restraint system that utilizes a sodium azide/potassium nitrate reaction for producing hot and fast blasts of nitrogen gas to inflate the airbag. The solid propellant from the standard supplemental restraint system can be volumetrically controlled for release into a combustion chamber in amounts required for a deployment force and acceleration corresponding to the weight of an occupant **20** in a seat **14**.

In one embodiment, electronic line signals are delivered and received as binaries that communicate between transistorized switches (not shown) that read the **1**s and **0**s as "off" and "on" as required for the components of the present invention to effectively communicate data back and forth. In other embodiments, a transient voltage suppressor **90** may be located between the control module **28** and the address line **40** within the CPU **30**. In the event of a transient voltage spike to the system **10** which would cause abnormal readings or reactions for the RAM **36**, a voltage suppressor **90** may be utilized to filter out transient spike phenomenon and ensure that accurate weight values are retained. With regard to binary signals, an "off" signal represents an open circuit and an "on" signal represents a closed circuit. Binary signals will logically be used to tell the CPU **30** the number of switches that need to be turned off and on to influence accurate responses to the operating weight values. Also, use of binaries will enable to the CPU **30** to activate devices that will initiate controlled energies toward the smart deployment of airbags **18** without causing injuries to occupant **20**. The CPU **30** uses logical functions to timely open and close all circuits within the transistorized switches. The logic depends on the switches to open and close on time for the system **10** to know the weight of the occupant **20** before activating the deployment force of the airbag **18**. The binary number system will allow the CPU **30** to do any other form of math. Everything in the CPU **30**, math, words, decimal numbers and software instructions, will communicate in the binary numbers. This means that the transistorized switches can do all types of manipulation. The clock (not shown) inside the CPU **30** regulates how fast the CPU should work, or how fast the transistorized switches should open or close. The faster the clock ticks or emits pulses, the faster the CPU will work. The speed is measured in gigahertz, which is billions of ticks per second. Electrical current passing through one transistorized switch may be used to control another transistorized switch, in effect turning the switch on and off to change what the second transistorized switch represents as a logic gate.

While various specific embodiments of the invention have been shown and described for purposes of illustration, the protection afforded by any patent which may issue upon this application is not strictly limited to the disclosed embodiments, but rather extends to all structures, arrangements and methods which fall fairly within the scope of the claims which are appended hereto: